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A preliminary study on the evaluation of casein, shrimp meal, squid meal and *spirulina* as protein sources for *Penaeus monodon* (Fabricius) postlarvae.

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Aquaculture has become a major factor in supplying protein for human consumption. Generally aquatic species with high market value are cultured intensively using artificial or expensive facilities and feeds. Penaeid shrimps which fit in this category have been cultured extensively in most coastal countries in Southeast Asia for many years, using wild collected postlarvae.

Protein is the most critical ingredient in shrimp diets from the standpoint of cost and growth response. Both quality and quantity of protein have remarkable effects on growth.

This experiment was designed to evaluate the effect of fresh brown mussel meat and various dietary protein sources (casein, shrimp meal, squid meal and *Spirulina)* on the growth and survival rate of *Penaeus monodon* postlarvae in a controlled environment.

P. monodon postlarvae with an average weight of 15.62 mg were stocked in 200-L cylindrical fiberglass tanks filled with 100 liters filtered seawater with salinity adjusted to 25 ppt at a density of 50 postlarvae per tank. They were fed with fresh brown mussel (*Modiolus metcalfei*) meat and artificial diets containing casein, shrimp (*Metapenaeus ensis*) meal, squid (*Loligo* sp.) meal and *Spirulina* as protein sources at a rate of 20% of their biomass per day for a period of 10 days. No statisitcal difference ($P<0.05$) was found among the weight gains of shrimp fed various experimental diets. However, shrimp fed squid meal diet had highest weight gain (15.95 mg), followed by shrimp meal (13.82 mg), fresh brown mussel meat (13.73 mg), casein (12.16 mg) and *Spirulina* (9.37 mg). Shrimp fed squid meal diet had significantly better $P<0.05$) feed conversion than those receiving other experimental diets. Feed conversion was identical for shrimp receiving casein and shrimp meal diets (2.46) and was slightly poorer than those fed brown mussel meat (2.38). Poorest feed conversion was observed in shrimp fed *Spirulina* diet. The protein efficiency

ratio (P. E. R.) was statistically highest ($P < 0.05$) for the squid meal diet (1.05). Next was the shrimp meal diet (0.91) which was significantly higher than that of the casein diet. The P. E. R. value of the *Spirulina* diet was significantly poorest (0.60) but was only slightly lower than that of fresh mussel meat (0.66). The survival rate was significantly highest for shrimp fed the shrimp meal diet (48.0). No statistical differences were found among shrimp fed other experimental diets.

Results of this preliminary study show that squid meal is superior to shrimp meal, fresh brown mussel meat, casein and *Spirulina* for the growth of *P. monodon* postlarvae when based on weight gain, diet conversion and P. E. R. Fresh brown mussel meat which was comparable to shrimp meal for growth, is inferior to shrimp meal when P. E. R. values and survival rates were compared. It appears that squid meal and shrimp meal are good protein sources for *P. monodon* postlarvae.

Table 1. Proximate chemical composition of fresh brown mussel (*Modiolus metcalfei*) meat.

Dry matter *(%)*	Protein *(%)*	Fat *(%)*	Ash *(%)*	Crude fiber *(%)*	NFE *(%)*
14.37	63.44	7.74	2.00	10.88	15.94

Table 2. Composition of four isonitrogenous, isocaloric diets containing various protein sources.

Ingredient	Percent in the diet			
	1	2	3	4
Casein	55	–	–	–
Shrimp meal	–	64.4	–	–
Squid meal	–	–	63.0	–
Spirulina	–	–	–	82.0
Dextrin	18.5	20.2	18.1	–
Cod liver oil	7.3	6.1	5.1	5.0
Vitamix mix*	1.5	1.5	1.5	1.5
Mineral mix*	5.0	5.0	5.0	5.0
Dicalcium phosphate	4.3	0.3	0.3	0.0
Calcium carbonate	2.65	0.0	5.1	4.95
B. H. T.	0.02	0.02	0.02	0.02
Celite (Filler)	5.73	2.48	1.88	1.53
Estimated protein (%)	50.0	50.0	50.0	50.0
Analyzed values	50.84	44.65	48.87	50.94
Estimated D.E.*** (Kcal/kg)	2925.0	2925.0	2925.0	2925.0

*Vitamin mix (mg/kg diet): Thiamin HCL, 36; riboflavin, 120; pyrodoxine HCL, 36; nicotinic acid, 480; Ca-panthothenate, 180; inositol, 2,400; biotin, 3.6; folic acid, 9.0; para-aminobenzoic acid, 240; choline chloride, 4,800; ascorbic acid, 6,000; L-tocopherol, 240; menadione-Na-bisulfite, 24; vitamin A, 13.8; calciferol, 3.6; cyanocabalamin, 0.24.

**Mineral mix (g/kg diet): K_2HPO_4, 10.75; $Ca(H_2PO_4)$ $2H_2O$, 13.25; $CaCO_3$, 5.25; Ca-lactate, 8.25; KCl, 1.40; $MgSO_4$, 7 H_2O, 5.0; Fe-citrate, 0.60; $ALCl_3$ 6 H_2O, 0.01198; $ZnSO_4$ 7 H_2O, 0.2380; $MnSO_4$ H_2O, 0.0405; $CuSO_4$ 5 H_2O, 0.01882; KI, 0.01151; $Co(NO_3)_2$ 6 H_2O, 0.08595.

***Estimated D. E. were based on the values found for channel catfish: Protein – 3.5 Kcal/g; Fat – 8.1 Kcal/g; NFE – 2.5 Kcal/g

Table 3. Cumulative weight gains at different periods for *Penaeus monodon* fed brown mussel meat and diet containing various protein sources.

Feeding regime	Initial weight (mg)	Average weight gain (mg) per prawn at different periods (days)	
		5	10
Fresh mussel meat	15.62	7.08	13.73
Casein diet	15.62	4.04	12.45
Shrimp meal diet	15.62	7.44	13.82
Squid meal diet	15.62	5.73	15.95
Spirulina diet	15.62	3.35	9.37

Table 4. Average weight gain, diet conversion, protein efficiency ratio and survival rate for *P. monodon* postlarvae fed fresh brown mussel meat and diets containing various protein sources.

Feeding Regime	Ave. weight gain (mg)	Conversion rate	P. E. R.	Survival rate (%)
Fresh brown mussel meat	13.73[a]	2.38[a]	0.66[a]	16[a]
Casein	13.16[a]	2.46[a]	0.80[b]	14[a]
Shrimp meal	13.82[a]	2.46[a]	0.91[c]	48[b]
Squid meal	15.95[a]	1.94[b]	1.05[d]	13[a]
Spirulina	9.37[a]	3.29[c]	0.60[a]	17[a]

[1] Treatment means with the same superscript are not statistically different at $P < 0.05$.

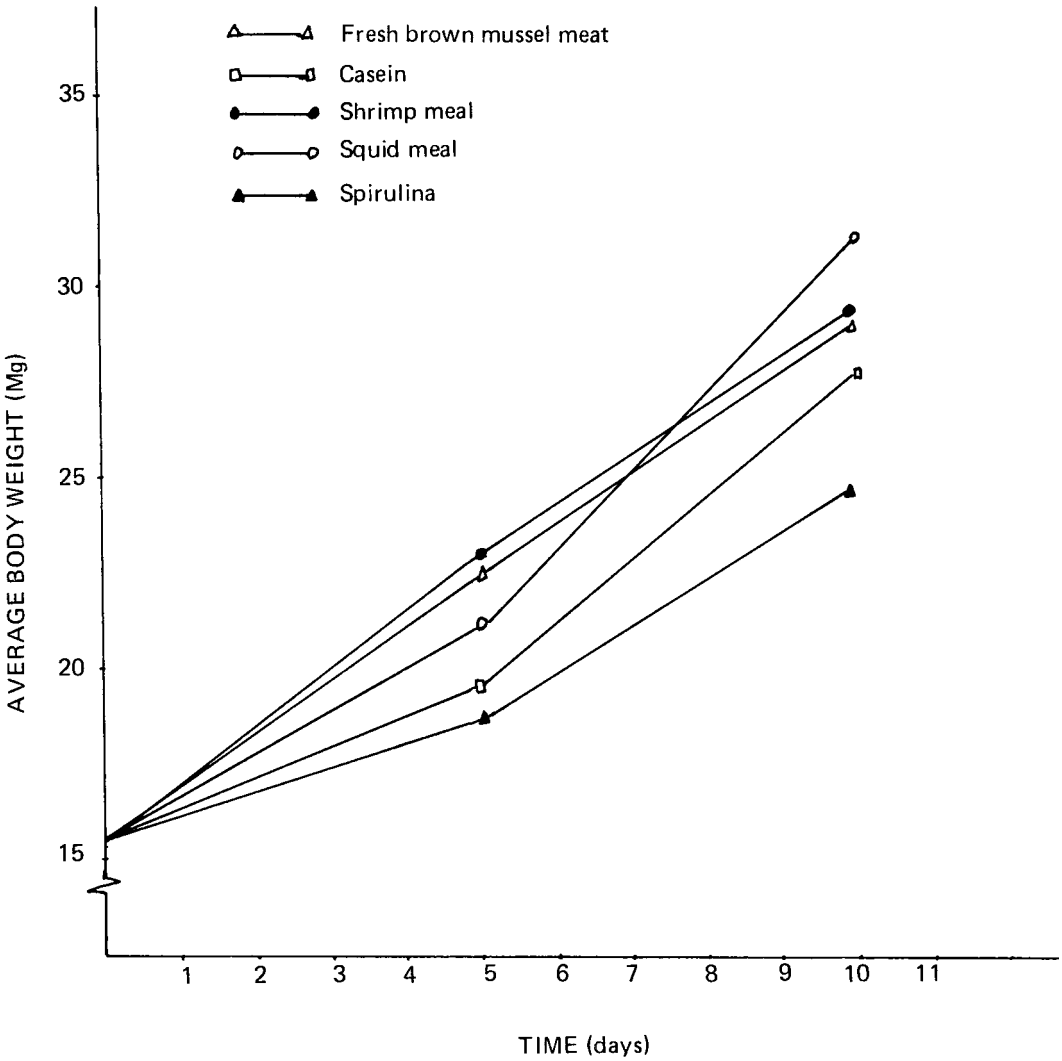

Figure 1. Growth rate of *P. monodon* postlarvae fed fresh brown mussel meat and diets containing various protein sources.

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